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ABSTRACT

A study investigated children's hypotheses about the meanings of novel verbs on the child's first exposure to the verb. The study focused on the properties (action, result, or instrument) ascribed to the verbs before any information was given about word meaning. Subjects were 3-year-olds, 5-year-olds, and adults. The stimuli were six sets of videotaped events, each matched with a novel verb. For each verb there were three training events in which two of the three properties of the verb remained constant while the other changed (i.e., for two verbs, the instrument varied; for two verbs, the result varied, and for two, the action varied). After the third training event for each verb, the subject was asked if the test event showed the same verb. Results suggest that this "fast mapping" is useful in characterizing the learning of verb meanings, but that the hypotheses that guide children's initial (default) mappings are still changing in the preschool years, and that important and hierarchical relationships between default values in verb properties might exist. (MSE)

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by

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AN EXAMINATION OF THE INITIAL MAPPING OF VERB MEANINGS

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It has become increasingly clear that children's learning of word meanings is best characterized as a rapid process that is directed at least in part by children's rough hypotheses about what novel words mean. This process, which has been called "fast-mapping", appears to be an apt description of how children learn the meanings of certain kinds of words, such as nouns and some adjectives, such as shape and color terms (Carey & Bartlett, 1978; Heibeck & Markman, 1987). Much less, however, is known about how children learn new verb meanings. Understanding what children assume a new verb means is important because verbs differ substantially from nouns and adjectives in their semantic organization, (e.g. Hutenlocher & Lui, 1979), and also because verbs and their argument structure are given roles of central importance in current theories of language acquisition (e.g. Bresnan, 1982; Pinker, 1984). This paper is addressed at precisely this issue: What are children's hypotheses about what a novel verb means upon their first exposure or exposures to that verb?

The theoretical framework that is used in this paper is one that claims that the mental representation of verb meanings, which I will be calling verb concepts, are best thought of as a type of schema such as a script (e.g. Schank & Abelson, 1976) or frame (Minsky, 1981), which belong to a class of representations that can be called "slot-filler" models (e.g. Nelson, 1986). The important feature of slot-filler models is that the representational structure has a number of placeholders, or "slots", that can be filled by a number of values, one or more of which may be more likely to occur or weighted most strongly in the representation. When studying children's assumptions about what novel verbs mean, we are interested in the default values for these slots; that is, the properties of these verb concepts before any information about the meaning of a given word is learned. These default values, according to a slot-filler model, serve to guide the verb learning process.

What information about verb meanings is contained in these slots? The two most commonly cited slots are action slots and result slots. Action slots contain information about the physical action performed by an agent in an event. Result slots contain information about the result of an event or the presumed goal of an action in the event. This distinction has been made commonly because some verbs explicitly label an action (such as "jump", "pound", "kick") without any reference to the result of that action, and other verbs explicitly label a result (such as "break", "melt", "clean") without specifying the action that produced the result. Most studies of the development of the verb lexicon and children's spontaneous use of verbs to label events have shown that action verbs tend to be used earlier and more frequently than result verbs by young children, with result verb usage increasing with age (e.g Behrend, 1987a; Bloom, Lightbown, & Hood, 1975).

A third slot of interest is an instrument slot. While an instrument slot is not essential to many verb meanings, it is of potential importance because there are verbs that explicitly label an instrument used in an event (such as "hammer", "mop", "harpoon") and because Clark (1981, 1982) and others have shown that some children will create innovative instrument verbs such as "brooming" and "pliersing" when these words are not in the adult lexicon (This occurs in languages other than English as well). I have found in earlier studies that while instrument verbs--appropriate or innovative--are rare in naturalistic speech, when children are asked to label events which have an appropriate instrument label as well as an appropriate action or result verb label, instrument verbs are used frequently, even by 3-year-olds. Instrument verb use also increases with age (Behrend, 1987a).

While studies of spontaneous verb use are instructive, they do not allow us to draw conclusions about default values of children's verb concepts. This is because there are many other factors, such as parental input, word frequency, and communicative context that may play important roles in determining what verb a child will use to label a given event at a given time. Also, when children label an event using a verb they alredy know, they are not relying on default values, but rather their existing verb concepts, in which action, result, and instrument slot values are already stored.

The strategy that I have used to study default values in verb concepts is to perform training studies in which children are taught novel verbs to label novel, videotaped events and then to test children's willingness to use these verbs to label additional events in which the instrument, action, or result is different from the events on which the verbs were trained. In the first study of this kind (Behrend, 1987b), children were taught six nonsense words. Each of the nonsense words was used to label three videotaped events in which an adult performed an unfamiliar action with a novel instrument that produced a clear result. After subjects were taught the novel verb, they were asked if they would use that verb to label additional events in which the instrument, action, or result was different from the events on which the verb was trained (the procedure will be described in detail when the main study of this paper is presented). It was found that all subjects were least willing to use a newly learned verb to label an event when the result was changed from the training events, followed by action and then instrument changes. A significant interaction showed that instrument changes were more important to preschoolers than adults and that result changes, though most important for all age groups, were least important for 3-year-olds. Action changes were moderately important for all age groups.

This experiment was an initial attempt at studying children's assumptions about verb meanings, and it raised many interesting questions. One important question is raised by the fact that in the training procedure that was used, all of the events on which a verb was trained were identical. Surely, this is not how verb learning occurs in the real world where various events can be labeled by the same verb. In fact, this variation between events is surely one of the factors that allows children to determine what, indeed, are the most crucial aspects of a particular verb's meaning and enables them to use the verb correctly. The study described in the remainder of this paper addresses this question by introducing systematic variations into the events used in the training procedure.

Method

Subjects

Twelve 3 year-olds (mean age 3;8) and 5-year-olds (mean age 5;4), and 12 adults (mean age 20;2) were subjects. There were eight boys and four girls in each group of preschoolers, and an equal number of adult males and females.

Materials

The stimuli were six sets of videotaped events each matched with a novel verb. The events and verbs used in the earlier study served as the basis for these events with some minor changes. For each verb, there were three training events. In all sets of training events, two of the three components (instrument, action, result) of the events remained constant while the other component was varied (the training variation). Thus, for two verbs the instrument varied; for two, the action varied; and for the remaining two, the result varied. Following the training events for each verb were 4 test events. One of the test events was identical to the first training event for that verb. In the other three test events, either the instrument, action, or result was changed (the test change). Table 1 shows three examples of the verbs and the

events that were used to teach them, one each in which the instrument, action, or result was varied in training. As there were two verbs used for each training variation, there were two trials for each of the possible training variation-test change combinations in the design. Thus, each subject made a total of 24 responses in the study. The test events on which no changes were made will not be discussed because subjects virtually always accepted the novel verb to label those events.

TABLE 1

Examples of novel verbs and events used in the training study.

---

1. **REMMING:** Twirling a ratchet (spaghetti server / bulb digger) to collect yarn from a table.

Test Changes: I = Barbecue tongs A = Scooping R = Dangle yarn

2. **CHIFFING:** (Sweeping / Spinning / Tapping tray) with a wok cleaner to move popcorn to side of tray.

Test Changes: I = Teflon Brush A = Pushing R = Divide in 2 piles

3. **STIPING:** Reaching over a cup with a bike lock to (slide it towards you. / flip it over. / drag it on its side.)

Test Changes: I = Rubber ring A = Inserting R = Crush cup

Procedure.

Before the first training event, the subject was told "Watch this person, she is remming." The first training event was then shown. Then, before the other two training events, the experimenter said, "Let's watch her do that again. Look, she's remming again." After the last training event, the subject was told, "O.K. Now I want you to tell me what she's doing. Look at her, and tell me if she is remming this time or if she's doing something else." The test event was shown, and the experimenter asked "Was she remming that time or was she doing something else?" This question format was used in order to avoid using a yes-no question. The order in which the novel verb and the phrase "something else" were heard was counterbalanced. After the last test event for a verb was shown, the training for the next verb began. Sessions lasted 15 to 20 minutes.

Results

The key dependent variable was the number of times subjects accepted the novel verb as a label for the test events. A 3 (Age) x 3 (Training Variation) x 3 (Test Change) ANOVA was used to analyze the data with the last two factors being within-subject factors. Table 2 summarizes the data. It should be kept in mind that lower values in this table represent stronger effects (i.e. subjects were less willing to accept the novel verb to label the test events). The significant main effect for test change,

$F(2,66) = 54.3$, $p<.001$, showed that, as in the earlier study, result changes had the strongest negative effect on subjects' acceptance of the novel verb, followed by action and instrument changes. There was also an age x test change interaction, $F(4,66) = 2.74$, $p<.05$, which showed that instrument changes were more important and result changes were less important to 3 year-olds than to either of the other age groups. Overall, the subjects in this study were more likely to accept the novel verb as a label for the test events than subjects in the earlier study. This was a direct effect of the variations in training that were introduced in the current study.

TABLE 2

Number of times novel verb is accepted as a label for test events (maximum value = 6)

	Age			
Test Change	Three	Five	Adult	Overall
Instrument	4.6	5.3	5.3	5.1
Action	3.3	2.6	3.3	3.1
Result	2.8	2.1	2.3	2.4
Mean	3.5	3.3	3.6	3.5

Of great interest in this study was precisely how the traing variations affected subjects' use of the novel verb and interacted with the test event changes. It was expected that if subjects were sensitive to the variations in the training, and, all other things being equal, then subjects would be more willing to accept the novel verb for a test event in which the aspect that was changed was also the aspect that was varied in the training for that verb. For example, subjects should be more willing to accept the novel verb as a label for the test events in which the action was changed when the actions were varied in the training events than when instruments or results were varied. These specific predictions were tested with a set of orthogonal planned comparisons based on the overall ANOVA.

Many of these predictions were confirmed. Figure 1 displays the significant interaction between training variation and test change, $F(4,132) = 24.7$, $p<.001$. It can be seen from the top panel in Figure 1 that when instruments were varied in training, the novel verb is no more likely to be accepted as a label for the test event in which the instrument is changed again than in the other two training conditions. This is primarily because instrument changes do not have much of an effect on use of the novel verb in the first place. However, the predicted effects for the action and result training variations were observed. That is, the novel verb was more likely to be accepted for action change test events when actions varied in the training events, $F(1,35) = 61.2$, $p<.01$, and it was more likely to be accepted for the result change test events when results varied in training compared to the other two training conditions, $F(1,35) = 7.17$, $p<.01$.

In addition, there was a 3-way interaction between age, training variation, and test change $F(8,132) = 2.78$, $p<.01$. Looking at the data for each age group, it was found that the findings for the instrument and action training variations held across age groups. That is, there was no effect for any age group for instrument variations, and there was a significant effect for all age groups for action variations. However,

FIGURE 1: DATA FOR ALL SUBJECTS

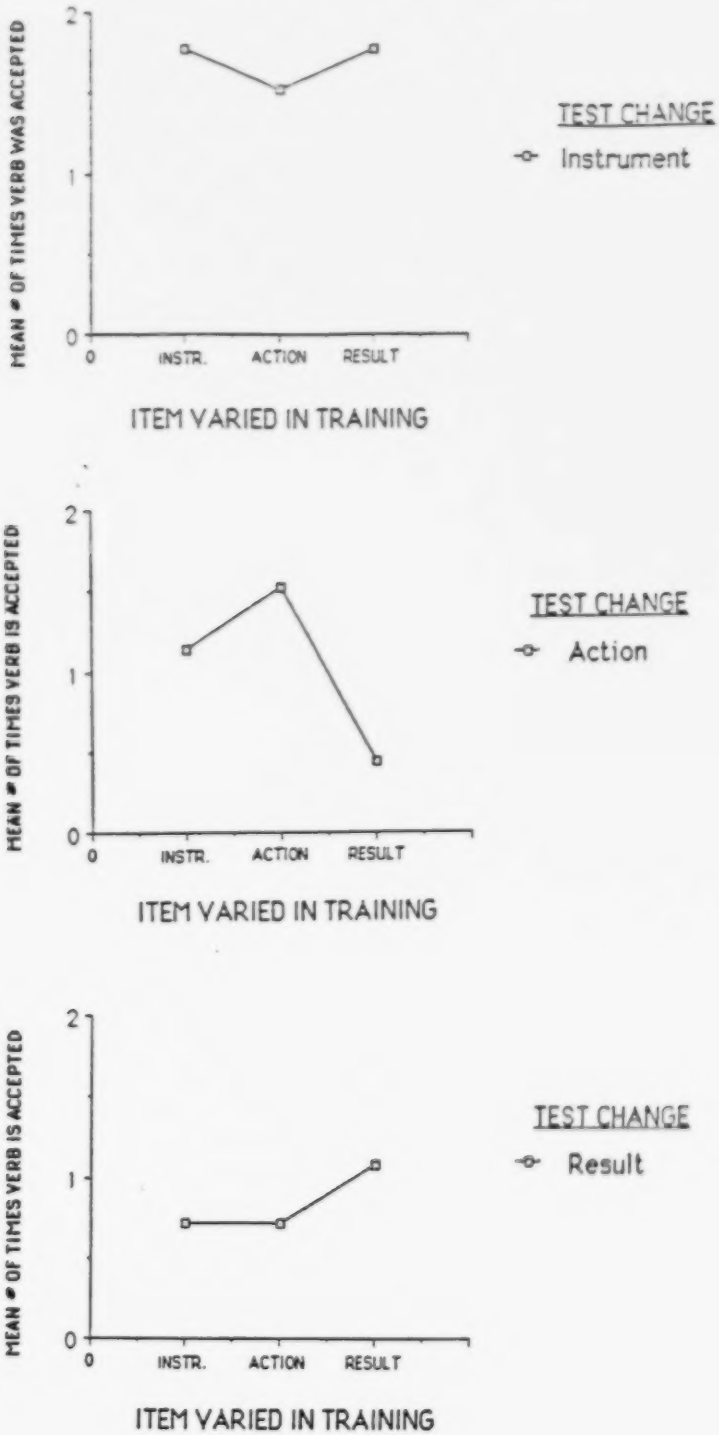
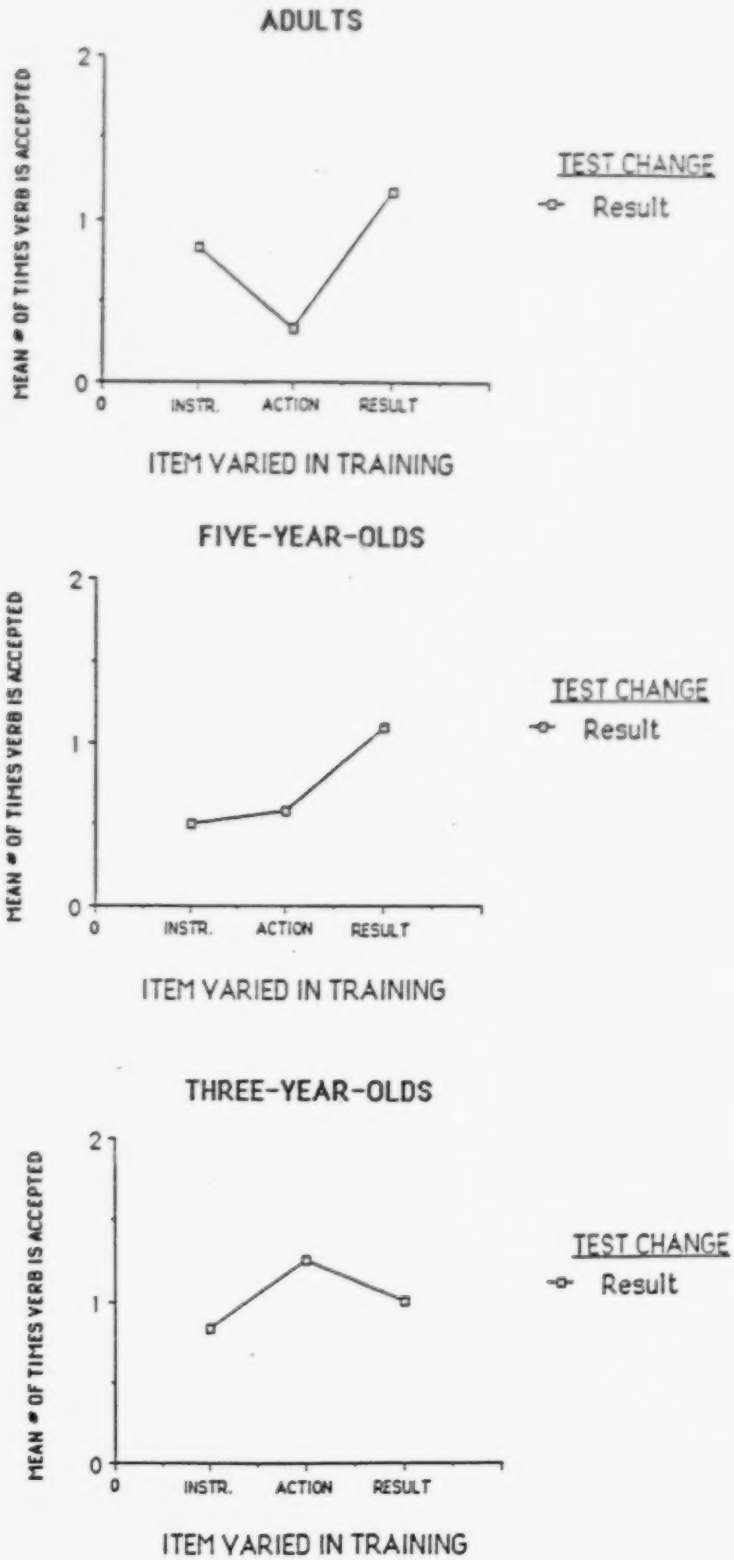


FIGURE 2: RESPONSES TO RESULT TEST CHANGES



varying the result in training had differential effects on the three age groups. Figure 2 shows that while there was no effect for the three year-olds, the predicted effect was seen somewhat in the five-year-olds, $F(1,11) = 4.96$, $p=.048$, and clearly in the adults, $F(1,11)=8.43$, $p<.03$.

In summary, when actions were varied in training, all age groups were more likely to accept the novel verb as a label for an event in which the action was changed again. When results were varied, only adults and five-year-olds were more likely to accept the verb as a label for a test event in which the result was changed again. Varying instruments in the training events had no effect on the use of the novel verb for any age group.

There is one other finding that is worthy of attention. Returning to the second graph in Figure 1, it can be seen that when results were manipulated in training, action changes had a profound negative effect across age groups on subjects' willingness to use the novel verb. What this finding suggests is that when results are varied and, thus, reduced in importance in the verb's meaning, perhaps some subjects abandoned the hypothesis that results are most important, and switched to action as the component most likely to be central to a novel verb's meaning. This was an unexpected finding and one deserving of further investigation.

Discussion

A picture is now beginning to emerge about children's initial mapping of verb meanings. When all other things are equal, it appears that the default assumption is that a novel verb is a result verb, as shown by children's unwillingness to use a newly learned verb to label an event in which the result was changed. This bias appears to increase with age. Actions are assumed to be less important than results, and instruments are rarely assumed to be important to novel verb meanings, though instruments were somewhat more important to 3-year-olds than to 5-year-olds and adults.

In addition, this study showed that some intriguing and potentially important things happen when children's default assumptions are in conflict with the input that is received about a verb's meaning. This was essentially what happened when results were varied in training in the present study, given that the assumption is that a novel verb is a result verb. It was found that when the result of an event was varied in training, adults, and to a lesser degree 5-year-olds, showed the predicted pattern of more frequently accepting the novel verb for an event in which the result was changed again. Some 5 year-olds, and to a much greater extent 3 year-olds, were apparently unable to override their default assumptions that the result is the most important component in a novel verb's meaning and frequently rejected the novel verb as an appropriate label for the test events in which the result was changed again. This is potentially an important developmental difference in the initial mapping of a verb meaning and merits further study.

It was also found that when results were varied in training, subjects of all ages rarely accepted the novel verb for the test event in which the action was changed. This finding suggests that there may be a ranking of sorts among the slots in verb concepts such that if results are decreased or eliminated in importance in a verb's meaning, then it is hypothesized that action, instead, is the key to the meaning of a novel verb. This account is similar to a "default rule hierarchy" that has been proposed to account for various types of animal, human, and machine learning (e.g. Holland, Holyoak, Nisbett, & Thagard, 1986) and demands consideration as the mechanism responsible for this finding of the present study.

Conclusion

To conclude, fast mapping appears to be a useful way to characterize the learning of verb meanings. However, it also appears that the hypotheses that guide children's initial mappings (i.e. their default values) are still changing in the preschool years and that there may be important and (perhaps) hierarchical relationships between default values in different slots in verb concepts. Additional research with younger children and a wider range of verbs will help to clarify the exact nature of the sources of these changes and the processes involved in the initial mapping of verb meanings.

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